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Research Article

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Characterization of salt-affected soils of Faizabad district

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Summary

A study was undertaken to characterize the soils of Faizabad district, Uttar Pradesh in order to assess their land capability. The soils were described in the morphology, characteristics. Themorphological properties of soils were studied and later on analyzed in laboratory for their physical and chemical properties. Thickness of Ap horizon was less in pedon number 1(20 cm), pedon number 2 and 3 (22 cm) and pedon number 4 and 5 (25 cm). The solum depth of all the profiles ranged from 85 to 100 cm. The colour of surface soil of pedons 1, 2, 3, 4 and 5 were light gray (10 YR 7/1 and 10YR 7/2) when dry and light yellowish brown (10 YR 6/4) when moist.The soil colour of sub-surface horizons was strong brown (7.5YR 5/6). Surface soil structure of the pedon was fine prismatic while it was fine sub-angular blocky of other pedons. The consistency of surface and sub-surface soils varied from slightly hard to very hard, friable to extremely firm.It was non-sticky, non-plastic to sticky, plastic in dry, moist and wet conditions, respectively in all the pedons.

Key words : Pedon, Horizon, Structure

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Introduction

Soil is a component of the lithosphere and biosphere system. It is a vital natural resource on which supporting life systems and socio-economic development depends. The crisis of land degradation is mainly related to increasing population pressure. The per capita cultivable land has been declined from 0.32ha in 1950's to 0.14 ha. in 2000 and will be less than 0.1 ha by 2020. The challenge is thus being faced not only of increasing productivity on sustainable basis, but also of the preserving and maintaining of soil resource base for the posterity. Information of soil and related properties obtained from the soil survey and soil classification can help in better delineation of soil and land suitability for irrigation and efficient irrigation water management. So, depending on the suitability of the mapped agro-ecological units for a set of crops, optimum cropping patterns have to be suggested taking into consideration the present cropping systems and the socio-economic conditions of the farming community (Sehgal *et al.*, 1989). Soil morphology has been studied in the field in their natural state and it deals with the form, structure and organization of the soil material that has genetically produced different horizontal layers, soil colour and other features. It is the reason why the study of SAS, as a pioneering branch of pedology, soil mapping, remote sensing, soil reclamation and soil utilization has received so much attention (Tinker

and Nye, 2000). As some tenths of Hungary's complete territory is covered by such soils, there has been and there is now a detailed work going on SAS (Szabolcs, 1971).

Resource and Research Methods

The study area was located in Faizabad district at $26^0$53.685'N latitude and $081^0$94.636'E longitude to $26^0$68.571'N latitude and $082^0$18.587'E longitude with an altitude of 106-113 m above mean sea level in the Gangetic eastern Uttar Pradesh. A detailed soil survey of the tract was carried out and four typifying pedon from higher to lower elevation representing four physiographic land froms were morphologically described. In this study, three profiles representing land under different land use were investigated for morphological and physico - chemical characteristics and also classification. The soil samples were taken from each layer in each profile of soil analysis. pH and electrical conductivity were determined in 1:2.5 (soil : water) suspension by using pH and conductivity meter, respectively. Bulk density at each sampling point was measured by soil core method and soil organic carbon content was determined by Walkley and Black's rapid titration method as described by Chopra and Kanwer (1976). The cation exchange capacity (CEC) of the soil was determined by the method described by NBSS and LUP Staff, 1984 and exchangeable sodium percentage (ESP) was calculated by the formula. Physical and chemical analysis of the soil samples from each horizon of the profiles were done following standard procedures.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Morphological characters :

The morphological characters are presented in Table 1 majority of the soils (P_1, P_2, P_3, P_4 and P_5) were characterized by 10YR as the common hue of the soil matrix with some variation in value and chromas. The soil colour of B horizon and C horizon were light brownish grey (10YR 6/2) when dry and dark grey brown (10YR 4/2) when moist.The soil structure was moderate, fine and prismatic at surface horizon while at the sub-surface horizon, it was strong and medium. In pedon 2, the surface horizon extends upto 22 cm. depth with solum extending 90 cm. The soil colour was light grey (10YR 7/1) when dry and pale brown (10YR 6/3) when moist. In pedon 3, the surface horizon extended up to 22 cm. depth with solum extending 85 cm. The soil colour was light grey (10YR 7/2) when dry and pale brown (10YR 6/3) when moist. The soil colour of B horizon and C horizon was light brownish yellow (10YR 6/6) when dry and yellowish brown (10YR 5/6) when moist. In pedon 4, the surface horizon extended upto 25 cm. depth with solum extending 100 cm. The colour of surface and sub-surface horizons was light grey (10YR 7/2) when dry to brownish yellow (10YR 6/6) and pale brown (10YR 6/3) when moist and in pedon 5, the surface horizon extended up to 25 cm. depth with solum extending 90 cm. The colour of surface and sub-surface horizons was light grey (10YR 7/1) when dry to brownish yellow (10YR 6/6) and pale brown (10YR 6/3) when moist. The soil colour of B horizon and C horizon was light brownish grey (10YR 6/2) when dry and yellowish brown (10YR 5/6) when moist. The consistency of surface horizon were moderate, fine and sub-angular blocky, respectively.

Structure :

The structure presented in Table 1 designates the mode of arrangement of the particles and their aggregates, therefore, the structural variation in soils are useful in differentiation of the horizon (Sharma *et al.*, 2004). Surface soil structure of the pedons 1 varied from moderate, fine, prismatic to strong, fine, prismatic. In other pedons 2, 3, 4 and 5, soil structure was found as moderate, fine sub-angular blocky to strong, medium, sub-angular blocky. Sub surface soil structure of the pedons 2, 3, 4 and 5 was sub-angular blocky while of pedons 1 was prismatic class (size) varied from fine to medium and grade (strength) varied from moderate to strong. The variation in soil structure might be due to the formation of natural peds (aggregates) through binding and cementing material. Aggregates formation depended upon interaction between exchangeable cations on the clay particles in the dispersion medium.

Physico-chemical properties :

Bulk density :

The soil bulk density values are presented in Table 2. The bulk density of soil in all the profiles (pedons) increased with increasing soil depth and ranged from 1.34 to 1.58 Mg m^{-3}. The minimum (1.34 Mg m^{-3}) and

maximum (1.58 Mg m^{-3}) values of bulk density were noted in pedon 5 in surface and in lower depth, respectively.

The chemical properties of soil are presented in (Table 2). The horizon was relatively less saline. This might be due to free drainage conditions which favoured the removal of salts by percolating water. Pillai and Natarajan (2004) also reported similar trends of EC values of salt-affected soils. The pH of soils of Faizabad, U.P. ranged from 7.75 to 10.41. The pH of surface soils was less in comparison to sub surface soils. The minimum value (7.75) of pH was recorded in surface layer of while it was maximum (10.41) in sub surface horizon of pedon 1. The organic carbon content ranged from 1.40 to 4.60 (g kg^{-1}). It was maximum in upper surface and minimum in lower horizon in all the pedons. The CEC in all the pedons increased with increasing soil depth. The distribution of CEC in all pedons was in the range 10.0 to 32.7cmol (p+) kg^{-1}. The exchangeable cationsin all the pedons were in order of Na^{+}> Ca^{+2}> Mg^{+2}> K^{+}. From the distribution of Ca^{+2} and Mg^{+2}, it is evident that Ca^{+2} shows the strongest relationship with all the cations. Comparing these ions (Na^{+}, Ca^{+2}, Mg^{+2} and K^{+}), it is clear that Mg^{+2} was present in lower amount than Ca^{+2}

Table 1: Morphological characteristics of the pedons

Horizon	Depth (cm)	Matrix colour (moist)	Structure	Consistency			Other features
				D	M	W	
Padon- 1: Ranapur (Haringtanganj)							
A_p	0 – 20	10 YR 6/3	2 f pr	sh	fr	ss sp	Thin roots are present in depth 0-20 cm.
B_1	20 – 36	10 YR 6/3	2 m pr	sh	fr	s p	
B_2	36 – 65	10 YR 4/3	3 m pr	h	fi	ss sp	
B_3	65 – 95	10 YR 4/2	3 m pr	vh	fi	ss sp	
C	95– 150	10 YR 4/2	Massive	vh	fi	so po	
Padon- 2: Kalyanpur (Haringtanganj)							
A_p	0 – 22	10 YR 6/3	2 f sbk	sh	fi	ss sp	Thin roots are present in depth of 0-25cm.
B_1	22– 42	10 YR 6/3	3 f sbk	h	sfi	ss sp	
B_2	42 – 65	10 YR 4/3	3 m sbk	h	sfi	s p	
B_3	65 – 90	10 YR 5/6	3 f sbk	vh	fi	sspo	
C	90 – 150	10 YR 5/6	Massive	vh	fi	so po	
Padon- 3:Shuklapurwa (Bikapur)							
A_p	0 – 22	10 YR 6/3	2 f sbk	sh	fi	ss sp	Thin roots are present at a depth of 0-25 cm and thick roots at a depth of 0-45cm. Clay films around sand are observed at a depth of 35-60 cm depth and motteles present at a depth of 60-120 cm.
B_1	22– 35	10 YR 6/3	3 f sbk	sh	sfi	ss sp	
B_2	35 – 60	10 YR 4/3	3 f sbk	sh	sfi	ss sp	
B_3	60 – 85	10 YR 5/6	3 f sbk	vh	sfi	sspo	
C	85 – 150	10 YR 5/6	Massive	vh	fi	so po	
Padon- 4:AvanpurSiroha (Masodha)							
A_p	0 – 25	10 YR 6/3	2 f sbk	sh	vfi	s p	Thin roots are present at a depth of 0-22 cm. Thick roots are present at a depth of 0-42 cm.
B_1	25 – 50	10 YR 6/3	2 f sbk	sh	vfi	s p	
B_2	50 – 80	10 YR 5/6	3 m sbk	h	fi	ss sp	
B_3	80 – 100	10 YR 5/6	3 m sbk	vh	fi	ss sp	
C	100 – 150	10 YR 5/6	Massive	vh	fi	so po	
Padon- 5:Kodri (PuraBajar)							
A_p	0 – 25	10 YR 6/3	2 f sbk	sh	fi	ss sp	Thin roots are present at a depth of 0-20 cm. Thick roots are present at a depth of 0-40 cm.
B_1	25 – 65	10 YR 6/3	3 f sbk	h	vfi	ss sp	
B_2	65 – 90	10 YR 5/6	2 m sbk	h	vfi	s p	
C	90 – 150	10 YR 5/6	Massive	vh	sfi	ss sp	

Structure: Size (S)- f-fine, m-medium, Grade (G) 2-moderate, 3-strong, Type (T) pr- prismatic, sbk-sub angular blocky, Consistency:
Dry (D), sh-slightly hard, h-hard, vh-very hard, Moist (M), fr-friable, fi-firm, vfi-very firm, sfi-slightly firm, Wet (W), so-non sticky, ss-slightly sticky, s-sticky, po-non plastic, sp-slightly plastic, p-plastic.

because of its higher mobility. Exchangeable sodium was observed more in all the pedons as compared to Ca^{+2}, Mg^{+2}, K^{+}. These results are in conformity with findings of Sharma (1996). In all the pedons, sodium was most dominant cation followed by calcium, magnesium and potassium throughout the profile. These results are similar to those of Sitanggang *et al*. (2006) in soils of Shikohpur watershed in Gurgaon district of Haryana. The distribution of organic carbon in these profiles is mainly associated with physiography and land use. The organic carbon content of surface soil was greater than sub-surface soil in all the pedons and it decreased with increasing soil depth. The part soil organic matter, dissolve in soil solution resulting black colour of the soil surface. The variation of organic carbon was because of the variation in extent of cultivation of various crops as well as incorporation of crop residues.

Electro-chemical properties :

The CEC in all the pedons increased with increasing soil depth. It is reflected by soil texture, organic matter, amount and kinds of clay content. In all the pedons, maximum CEC was observed in the horizon where illuviation of clay from surface to sub-surface horizons had taken place. Similar observations were also made by Pillai and Natarajan (2004).

Table 2 : Physico-chemical characteristics of the soils

Horizon	Depth (cm)	B.D. ($Mg\ m^{-3}$)	pH (1:2.5)	O.C. ($g\ kg^{-1}$)	CEC	Exchangeable cations				ESP
						Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	
					[cmol (p^{+})kg^{-1}]					
Padon- 1: Ranapur (Haringtanganj)										
A_p	0 – 20	1.38	9.58	2.40	18.4	3.5	3.2	10.4	0.6	56.52
B_1	20 – 36	1.42	9.87	2.20	22.5	3.7	3.3	14.1	0.7	62.66
B_2	36 – 65	1.45	10.24	2.00	27.9	3.8	3.4	19.5	0.8	69.89
B_3	65 – 95	1.54	10.36	1.80	30.5	3.9	3.5	22.0	0.8	72.13
C	95– 150	1.57	10.41	1.50	32.7	4.0	3.5	23.9	0.9	73.08
Padon- 2: Kalyanpur (Haringtanganj)										
A_p	0 – 22	1.35	8.87	3.20	12.5	3.9	3.4	4.1	0.5	32.80
B_1	22– 42	1.39	8.93	2.70	13.7	4.0	3.5	5.0	0.6	36.49
B_2	42 – 65	1.42	8.98	2.50	14.6	4.1	3.6	5.7	0.6	39.04
B_3	65 – 90	1.47	9.07	1.90	16.3	4.2	3.7	6.9	0.7	42.33
C	90 – 150	1.53	9.23	1.40	18.2	4.4	3.9	8.6	0.7	47.25
Padon- 3:Shuklapurwa (Bikapur)										
A_p	0 – 22	1.37	8.66	3.30	11.2	4.0	3.7	2.6	0.5	23.21
B_1	22– 35	1.38	8.70	2.20	12.0	4.1	3.8	3.0	0.5	25.00
B_2	35 – 60	1.42	8.73	1.70	12.7	4.2	3.9	3.3	0.6	25.98
B_3	60 – 85	1.50	8.81	1.60	13.6	4.4	4.1	4.1	0.6	30.14
C	85 – 150	1.52	8.89	1.40	15.3	4.6	4.3	5.3	0.7	34.64
Padon- 4:AvanpurSiroha (Masodha)										
A_p	0 – 25	1.42	8.54	4.60	11.1	4.2	3.9	1.9	0.5	17.11
B_1	25 – 50	1.46	8.60	3.70	11.5	4.3	4.0	2.3	0.6	20.0
B_2	50 – 80	1.49	8.71	2.90	12.7	4.4	4.1	3.2	0.7	25.19
B_3	80 – 100	1.54	8.84	2.50	15.0	4.6	4.3	4.8	0.8	32.00
C	100 – 150	1.57	8.93	1.90	16.9	4.8	4.5	6.2	0.9	36.68
Padon- 5:Kodri (PuraBajar)										
A_p	0 – 25	1.34	7.75	2.60	10.0	4.3	3.8	0.5	0.5	5.00
B_1	25 – 65	1.36	7.97	2.40	10.4	4.4	3.9	0.8	0.5	7.69
B_2	65 – 90	1.38	8.52	2.00	11.2	4.4	3.9	1.8	0.6	16.07
C	90 – 150	1.58	8.67	1.60	12.3	4.3	4.0	2.9	0.7	23.57

Conclusion :

The soils of Faizabad district studied were found to be saline to alkaline in nature with low organic carbon content, medium to high in cation exchange capacity and high in ESP, SAR and exchangeable sodium. The trends of exchangeable cations was Na^{+}> Ca^{+2}> Mg^{+2}> K^{+}.

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